(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 178 565 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
06.02.2002 Bulletin 2002/06

(51) Int Cl.7: H01Q 11/08

(21) Application number: 01116452.2

(22) Date of filing: 06.07.2001

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE TR
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: 31.07.2000 JP 2000231117

(71) Applicant: Murata Manufacturing Co., Ltd.
Nagaokakyo-shi Kyoto-fu 617-8555 (JP)

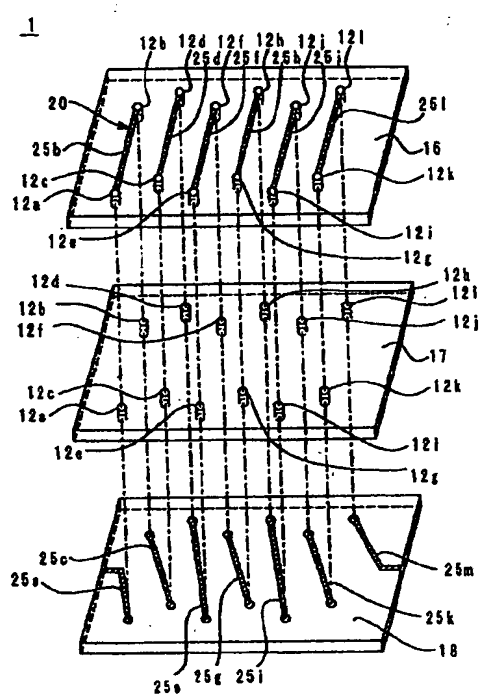
(72) Inventors:
- Shiroki, Koji, c/o (A170) Intel. Prop. Dept.
Nagaokakyo-shi, Kyoto-fu 617-8555 (JP)
- Asakura, Kenji, c/o (A170) Intel. Prop. Dept.
Nagaokakyo-shi, Kyoto-fu 617-8555 (JP)

(74) Representative: Schoppe, Fritz, Dipl.-Ing.
Patentanwälte Schoppe, Zimmermann,
Stöckeler & Zinkler, Postfach 71 08 67
81458 München (DE)

(54) Chip antenna

(57) A chip antenna (1) capable of reducing the spiral pitch of an antenna line (20) to be smaller than that of a conventional one. Conductor patterns (25a - m) are electrically connected sequentially in series through via holes (12a - 1) so as to form a spiral antenna line (20). The antenna line (20) has a winding axis which is arranged either in a zigzag manner or along a straight line. Adjacent wound portions have an equal diameter or width or the adjacent portions may have unequal widths. Since adjacent via holes are arranged in a staggered arrangement with each other, the distance (P2) between the adjacent via holes is larger than the spiral pitch (P1) of the antenna line, allowing the adjacent portions to be closer together than a conventional chip antenna, thereby allowing the resonance frequency to be reduced.

FIG.1



EP 1 178 565 A1

Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to chip antennas, and in particular relates to a chip antenna for mobile communication units such as portable telephone terminals and pagers and a chip antenna for local area networks (LANs).

2. Description of the Related Art

[0002] It is important for antennas for use in mobile communication units and LANs to be small-sized. As one of the antennas satisfying such a demand, a helical-type chip antenna is known.

[0003] An example of a conventional helical-type chip antenna is shown in Figs. 9 and 10. A chip antenna 100 comprises a rectangular-solid dielectric base body 121, an antenna line 130 disposed in the dielectric base body 121, a feed terminal 110, and a fixing terminal 111. One end 134 of the antenna line 130 is electrically connected to the feed terminal 110 and the other end 135 is unconnected.

[0004] The antenna line 130 is formed by alternately connecting a conductor pattern 131 and a via hole 132 in series. The antenna line 130 has a helical structure having a uniform width and height (or diameter) and the pitch P, and is wound about a straight axis CL in the horizontal direction (direction of arrow X in the drawing).

[0005] In order to enable a chip antenna also to be used at low frequencies, the chip antenna is generally required to reduce the resonance frequency. One of the methods for reducing the resonance frequency of the chip antenna is to decrease the spiral pitch of the antenna line.

[0006] However, since in the conventional chip antenna 100, adjacent via holes 132 are close to each other, there is a problem that the spiral pitch of the antenna line 130 cannot be reduced much due to limitation in manufacturing.

SUMMARY OF THE INVENTION

[0007] Accordingly, it is an object of the present invention to provide a chip antenna capable of reducing the spiral pitch of an antenna line so that it is smaller than that of a conventional chip antenna.

[0008] In order to achieve the above-mentioned object, in accordance with a first aspect of the present invention, a chip antenna comprises a base body, an antenna line disposed in the base body and being spirally wound, and a feed terminal disposed on a surface of the base body and being electrically connected to one end of the antenna line, wherein the antenna line has a winding axis which curves in a zigzag manner.

[0009] In accordance with a second aspect of the present invention, a chip antenna comprises a base body, an antenna line disposed in the base body and being spirally wound, and a feed terminal disposed on a surface of the base body and being electrically connected to one end of the antenna line, wherein the antenna line has a substantially straight winding axis, and adjacent wound portions have a different width or diameter.

[0010] More specifically, the antenna line may be formed by electrically connecting a plurality of conductor patterns disposed in the base body in series by via holes which are arranged in the base body in a staggered arrangement.

[0011] By the structures described above, the minimum spiral pitch of the antenna line can be smaller than that of a conventional antenna, thereby enabling the resonance frequency of the chip antenna to be reduced to less than that of a conventional chip antenna.

[0012] A chip antenna according to the present invention may further comprise an opposing conductor for adjusting the resonance frequency, wherein the opposing conductor opposes at least one of the plurality of conductor patterns forming the antenna line and is electrically connected to part of the plurality of conductor patterns. Thereby, when the area of the opposing conductor for adjusting the resonance frequency is changed, the resonance frequency of the chip antenna can be adjusted without changing the number of winding turns of the antenna line.

BRIEF DESCRIPTION OF THE DRAWING(S)

[0013]

Fig. 1 is an assembly view of a chip antenna according to a first embodiment of the present invention;
Fig. 2 is a perspective view of the chip antenna shown in Fig. 1;
Fig. 3 is a plan view of the chip antenna shown in Fig. 1;
Fig. 4 is an assembly view of a chip antenna according to a second embodiment of the present invention;
Fig. 5 is a perspective view of the chip antenna shown in Fig. 4;
Fig. 6 is a plan view of the chip antenna shown in Fig. 4;
Fig. 7 is a plan view of a chip antenna according to a third embodiment of the present invention;
Fig. 8 is a plan view of a chip antenna according to another embodiment of the present invention;
Fig. 9 is a perspective view of a conventional chip antenna; and
Fig. 10 is a plan view of the chip antenna shown in Fig. 9.

DETAILED DESCRIPTION OF EMBODIMENTS OF THE INVENTION

[0014] Embodiments according to the present invention will be described below with reference to the attached drawings.

(First Embodiment, Figs. 1 to 3)

[0015] Fig. 1 is an assembly view showing a chip antenna 1; Fig. 2 is an external perspective view of the chip antenna 1 shown in Fig. 1; and Fig. 3 is a plan view of the chip antenna 1 shown in Fig. 1.

[0016] As is shown in Fig. 1, the chip antenna 1 comprises a dielectric sheet 16 having conductor patterns 25b, 25d, 25f, 25h, 25j, and 251 and via holes 12a to 121 formed thereon, a dielectric sheet 17 having the via holes 12a to 121 formed thereon, and a dielectric sheet 18 having conductor patterns 25a, 25c, 25e, 25g, 25i, 25k, and 25m formed on the top face of the dielectric sheet 18.

[0017] The conductor patterns 25a to 25m are formed on the surfaces of the respective dielectric sheets 16 and 18 by a method such as printing, sputtering, vapor deposition, pasting, or plating. As a material of the conductor patterns 25a to 25m, Ag, Ag-Pd, Au, Pt, Cu, Ni, etc., are used. As a material of the dielectric sheets 16 to 18, a resin such as a fluorocarbon resin, ceramic containing barium oxide, aluminum oxide, silica, etc. as principal ingredients, and a mixture of ceramic and a resin are used. The via holes 12a to 121 may be formed by filling holes formed on the dielectric sheets 16 and 17 with conductive paste.

[0018] The conductor patterns 25a to 25m are electrically connected sequentially in series by the via holes 12a to 121 formed on the dielectric sheets 16 and 17 so as to form a spiral antenna line 20. One end of the spiral antenna line 20 (i.e., the conductor pattern 25a) is exposed to the left side of the conductor sheet 18 and the other end (i.e., the conductor pattern 25m) is exposed to the right side of the conductor sheet 18.

[0019] The conductor patterns 25b, 25d, 25f, 25h, 25j, and 251 formed on the surface of the dielectric sheet 16 have an equal length and are arranged in parallel to each other at intervals of a predetermined pitch. The conductor patterns 25b, 25f, and 25j and the conductor patterns 25d, 25h, and 251 are each alternately arranged in a staggered arrangement. Similarly, the conductor patterns 25a, 25c, 25e, 25g, 25i, 25k, and 25m formed on the top surface of the dielectric sheet 18 also have an equal length and are arranged in parallel to each other at intervals of a predetermined pitch. Furthermore, the via holes 12a, 12c, 12e, 12g, 12i, and 12k are alternately arranged in a staggered arrangement, and the via holes 12b, 12d, 12f, 12h, 12j, and 121 are alternately arranged in a staggered arrangement.

[0020] The dielectric sheets 16 to 18 described above, as shown in Fig. 1, are sequentially deposited and unitarily burned so as to form a dielectric base body 11 as shown in Fig. 2. At both ends of the dielectric base body 11, terminals 21 and 22 are respectively disposed. The terminal 21 is electrically connected to the conductor pattern 25a while the terminal 22 is electrically connected to the conductor pattern 25m. Any one of the terminals 21 and 22 is used as a feed terminal and the other is for as a fixing terminal. The terminals 21 and 22 may be formed of conductive paste such as Ag, Ag-Pd, Cu, or Ni by a method such as coating, burning, or further wet plating thereon.

[0021] In the chip antenna 1 formed as described above, as shown in Fig. 3, the antenna line 20 has a winding axis CL which curves in a zigzag manner, and adjacent spiral portions have an equal diameter. Since adjacent via holes (the via holes 12a, 12c, 12e, 12g, 12i, and 12k, for example) are arranged in a staggered arrangement with each other, the distance P2 between adjacent via holes (the via holes 12a and 12c, for example) is larger than the spiral pitch P1 of the antenna line 20. Therefore, even when the spiral pitch P1 of the antenna line 20 is reduced to be smaller, the distance P2 between the adjacent via holes 12a and 12c can be larger than that of a conventional antenna line, so that limitation in manufacturing may be circumvented. Consequently, the minimum spiral pitch of the antenna line 20 can be smaller than that of a conventional one, thereby enabling the resonance frequency of the chip antenna 1 to be reduced approximately 20% smaller than that of a conventional chip antenna.

(Second Embodiment, Figs. 4 to 6)

[0022] Fig. 4 is an assembly view of a chip antenna 2; Fig. 5 is an exterior perspective view of the chip antenna 2 shown in Fig. 4; Fig. 6 is a plan view of the chip antenna 2 shown in Fig. 4; however, in Fig. 6, an opposing conductor 23 for adjusting the resonance frequency and a via hole 32m are not shown.

[0023] As is shown in Fig. 4, the chip antenna 2 comprises a dielectric sheet 15 having the opposing conductor 23 for adjusting the resonance frequency and the via hole 32m formed thereon, a dielectric sheet 16 having conductor patterns 45b, 45d, 45f, 45h, 45j, and 451 and via holes 32a to 321 formed thereon, a dielectric sheet 17 having the via holes 32a to 321 formed thereon, and a dielectric sheet 18 having conductor patterns 45a, 45c, 45e, 45g, 45i, 45k, and 45m formed on the top face of the dielectric sheet 18.

[0024] The conductor patterns 45a to 45m are electrically connected sequentially in series via the via holes 32a to 321 formed on the dielectric sheets 16 and 17 so as to form a spiral antenna line 40. One end of the spiral antenna line 40 (i.e., the conductor pattern 45a) is exposed to the left side of the conductor sheet 18 and the other end (i.e., the conductor pattern 45m) is exposed to the right side of the conductor sheet 18.

[0025] The conductor patterns 45b, 45f, and 45j

formed on the top surface of the dielectric sheet 16 have an equal length and are arranged alternately with and in parallel to the conductor patterns 45d, 45h, and 451 having a smaller length than that of the conductor patterns 45b, 45f, and 45j at intervals of a predetermined pitch. Similarly, the conductor patterns 45a, 45c, 45e, 45g, 45i, 45k, and 45m formed on the top surface of the dielectric sheet 18 also have an equal length and are arranged at intervals of a predetermined pitch. Furthermore, the via holes 32a, 32c, 32e, 32g, 32i, and 32k are alternately arranged in a staggered arrangement, and the via holes 32b, 32d, 32f, 32h, 32j, and 321 are alternately arranged in a staggered arrangement.

[0026] The opposing conductor 23 for adjusting the resonance frequency is formed in a position opposing the conductor patterns 45h to 451 and is electrically connected to the conductor pattern 451 via the via hole 32m.

[0027] The dielectric sheets 15 to 18 described above, as shown in Fig. 4, are sequentially deposited and unitarily burned so as to form a dielectric base body 11a as shown in Fig. 5. At both ends of the dielectric base body 11a, terminals 21 and 22 are respectively disposed. The terminal 21 is electrically connected to the conductor pattern 45a while the terminal 22 is electrically connected to the conductor pattern 45m.

[0028] In the chip antenna 2 formed as described above, as shown in Fig. 6, the antenna line 40 has a straight winding axis CL, and adjacent wound portions thereof have a different diameter. Since adjacent via holes (the via holes 32a, 32c, 32e, 32g, 32i, and 32k, for example) are arranged in a staggered arrangement, the distance P2 between adjacent via holes (the via holes 32a and 32c, for example) is larger than the spiral pitch P1 of the antenna line 40. Therefore, even when the spiral pitch P1 of the antenna line 40 is reduced to be smaller, the distance P2 between the adjacent via holes 32a and 32c can be larger than that of a conventional antenna line, so that limitation in manufacturing may be circumvented. Consequently, the minimum spiral pitch of the antenna line 40 can be smaller than that of a conventional one, thereby enabling the resonance frequency of the chip antenna 2 to be reduced approximately 20% smaller than that of a conventional chip antenna.

[0029] As is shown in Fig. 5, the opposing conductor 23 for adjusting the resonance frequency formed on the top surface of the dielectric base body 11a is cut by forming a slit 23a on the opposing conductor 23 using a laser, sandblasting, etching, a knife, etc. The area of the opposing conductor 23 for adjusting the resonance frequency being connected to the antenna line 40 is thereby reduced, enabling the resonance frequency of the chip antenna 2 to be changed. Accordingly, even after forming the dielectric base body 11a, the resonance frequency can be adjusted to be a desired value, thereby improving the yield of the chip antenna 2.

(Third Embodiment, Fig. 7)

[0030] Fig. 7 is a plan view of a chip antenna 3 according to a third embodiment. In the third embodiment, a spiral antenna line 60 is arranged in a dielectric base body 11b, in which the diameter of the spiral line 60 increases gradually as the winding proceeds.

[0031] Conductor patterns 65a to 65m formed in the dielectric base body 11b are electrically connected sequentially in series through via holes 52a to 521 formed in the dielectric base body 11b so as to form a spiral antenna line 60. The conductor patterns 65b, 65f, and 65j and the conductor patterns 65d, 65h, and 651 are arranged at intervals of a predetermined pitch and each length thereof increases gradually in order. The via holes 52b, 52d, 52f, 52h, 52j, and 521 are arranged in a staggered arrangement. The via holes 52a, 52c, 52e, 52g, 52i, and 52k are also arranged in a staggered arrangement.

[0032] In the chip antenna 3 formed as described above, just like in the second embodiment, the antenna line 60 has a straight winding axis CL, and adjacent wound portions thereof have a different diameter. Since adjacent via holes (the via holes 52a, 52c, 52e, 52g, 52i, and 52k, for example) are arranged in a staggered arrangement, the distance P2 between adjacent via holes (the via holes 52a and 52c, ' for example) is larger than the spiral pitch P1 of the antenna line 60. Therefore, even when the spiral pitch P1 of the antenna line 60 is reduced to be smaller, the distance P2 between the adjacent via holes 52a and 52c can be larger than that of a conventional antenna line, so that limitation in manufacturing may be circumvented. Consequently, the minimum spiral pitch of the antenna line 60 can be smaller than that of a conventional one, thereby enabling the resonance frequency of the chip antenna 3 to be reduced smaller than that of a conventional chip antenna.

(Other Embodiments)

[0033] The present invention is not limited to the above-described embodiments, however. Various modifications can be made within the scope of the invention. For example, in the embodiments, the cross-section of the spiral antenna line is rectangular; however it may have an arbitrary shape such as a substantially track shape having straight portions and curved portions or a semi-cylindrical shape. The dielectric base body may be spherical, cubic, cylindrical, conical, or pyramidal as well as being rectangular solid. The entire or part of the antenna line may be embedded into the base body. Also, the entire conductor patterns may be formed on a surface of the base body 11 by using the dielectric sheet 19 shown in Fig. 8 instead of the dielectric sheet 18 according to the first embodiment shown in Fig. 1. Furthermore, the base body may be formed from a magnetic material. One end of the antenna line may be open as shown in Fig. 9.

[0034] Although the present invention has been described in relation to particular embodiments thereof, many other variations and modifications and other uses will become apparent to those skilled in the art. It is preferred, therefore, that the present invention be limited not by the specific disclosure herein, but only by the appended claims.

Claims

1. A chip antenna (1) comprising:

   a base body (11);
   an antenna line (20) disposed on or in the base body (11) and being spirally wound; and
   a feed terminal (21, 22) disposed on a surface of the base body (11) and being electrically connected to one end (25a, 25m) of the antenna line (20),

   wherein the antenna line (20) has a winding axis which is arranged in a zigzag manner.

2. The chip antenna of claim 1, wherein the base body (11) comprises a plurality of laminations (16, 17, 18), at least two (16, 18) of the laminations having conductors (25a - 25m) disposed thereon with conductive via holes (12a-l) connecting the conductors (25b, d, f, h, j, l) on a first lamination (16) to conductors (45a, c, e, g, i, k) on a second lamination (18) thereby forming the spirally wound antenna line (20) having a rectangular cross section and having a defined pitch (P1) and wherein a distance (P2) between adjacent through holes (12a-l) is greater than the pitch (P1).

3. A chip antenna (2;3) comprising:

   a base body (11a; 11b);
   an antenna line (40; 60) disposed on or in the base body (11a; 11b) and being spirally wound; and
   a feed terminal (21, 22) disposed on a surface of the base body 11a; 11b) and being electrically connected to one end of the antenna line (40; 60),

   wherein the antenna line (40; 60)has a substantially straight winding axis, and adjacent wound portions have a different width.

4. The chip antenna (2) of claim 3, wherein the base body comprises a plurality of laminations (16, 17, 18), two (16, 18) of the laminations having conductors 45a - m) disposed thereon with conductive via holes (32a-l) connecting the conductors (45b, d, f, h, j, l) on a first lamination (16) to conductors (45a, c, e, g, I, k) on a second lamination (18) thereby forming the spirally wound antenna line (40) having a rectangular cross section and having a defined pitch (P1) and wherein a distance (P2) between adjacent through holes (32a-1) is greater than the pitch (P1).

5. A chip antenna (1; 2; 3) of Claim 1 or 3, further comprising:

   a plurality of conductor patterns (25a - m; 45a - m; 65 a - m) disposed in the base body (11; 11a; 11b); and
   via holes (12a-l; 32a-l; 52a-l),

   wherein the antenna line (20; 40; 60) is formed by electrically connecting the plurality of conductor patterns (25a- m; 45a - m; 65a - m) in series by the via holes (12a-l; 32a-l; 52a-l) which are arranged in the base body (11; 11a; 11b) in a staggered arrangement.

6. The chip antenna (1; 2; 3) of claim 1, 3 or 5 further comprising an opposing conductor (23) for adjusting the resonance frequency, wherein the opposing conductor (23) opposes at least one (45h-l) of the plurality of conductor patterns (45a - m) forming the antenna line (40) and is electrically connected to part (451) of the plurality of conductor patterns (45a - m).

7. The chip antenna 1;2 of claim 1, wherein the antenna line has a substantially rectangular cross section.

8. The chip antenna (1; 2; 3) of claim 1, 3 or 5 wherein the base body (11; 11a; 11b) comprises one of a dielectric and a magnetic element.

9. The chip antenna 1 of claim 2, wherein adjacent conductors on at least one of the laminations (16, 18) have equal lengths.

10. The chip antenna (2) of claim 4, wherein adjacent conductors on both laminations (16, 18) have unequal lengths.

11. The chip antenna (2) of claim 4, wherein the width of adjacent conductors (45a - m) on at least one of the laminations (16, 18) increases from a first end of the base body (11a) to a second end.

12. The chip antenna of claim 1 or wherein the antenna line (20; 40; 60) has a terminal (21) for connection to a power feed at one end (25a).

13. The chip antenna of claim 12, wherein the antenna line (20; 40; 60) has a second end (25m) that is pro-

vided to a second terminal (22) or left unconnected.

FIG.1

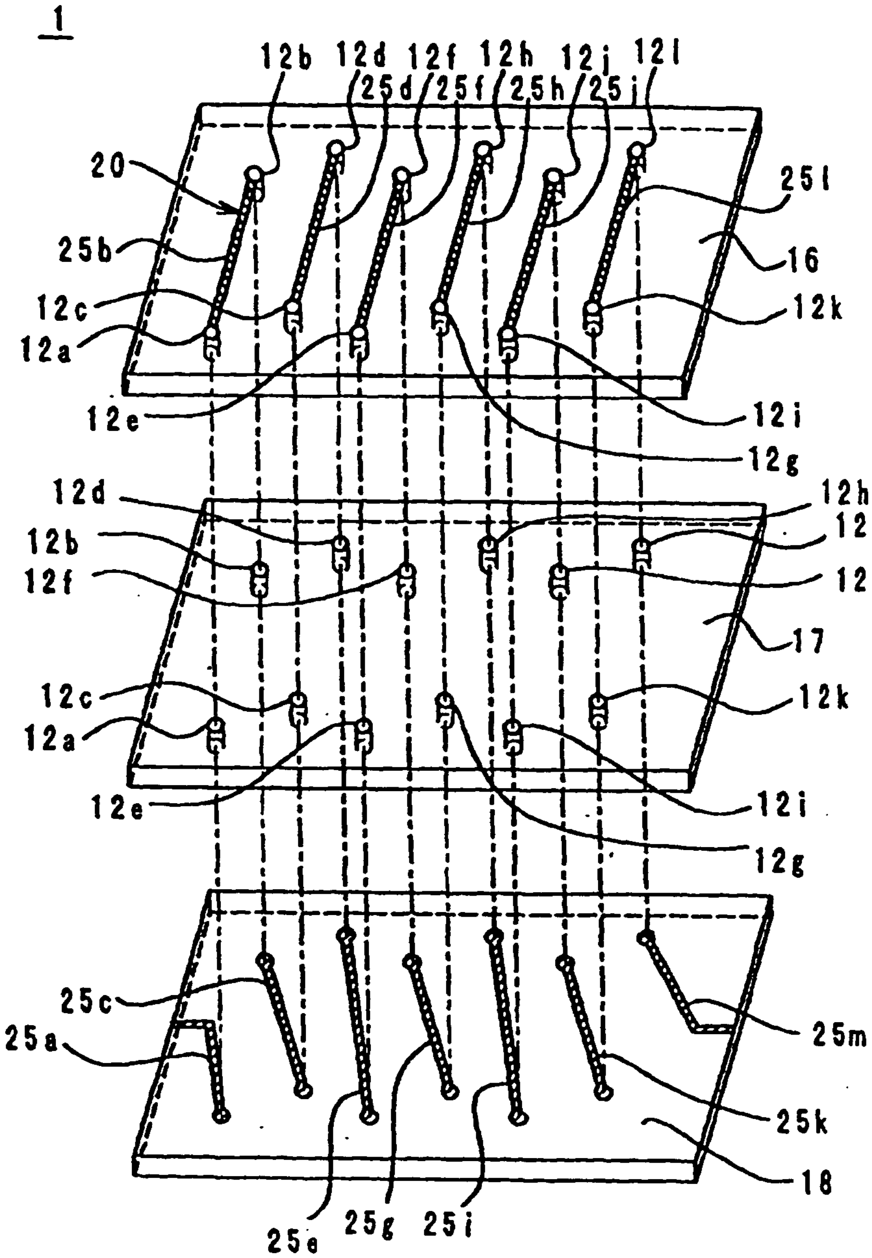

1
12b
12d
12f
12h
12j
12l
25d
25f
25h
25j
20
25l
25b
16
12c
12k
12a
12e
12i
12g
12d
12h
12b
12l
12f
12j
17
12c
12k
12a
12e
12i
12g
25c
25m
25a
25k
18
25e
25g
25i

FIG.2

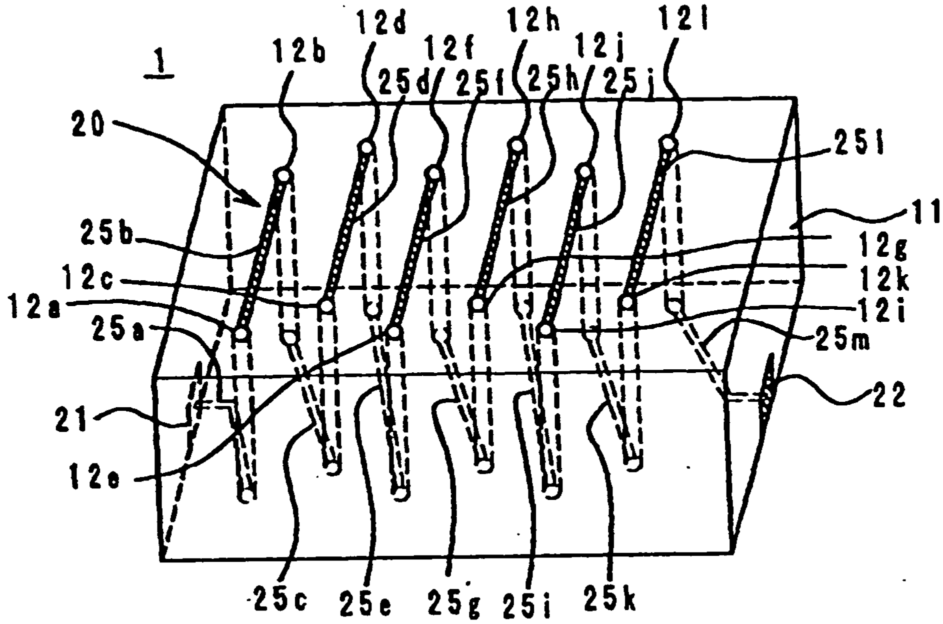

1
20
12b
12d
12f
12h
12j
12l
25d
25f
25h
25j
25l
11
12g
12k
12i
25m
25b
12c
12a
25a
21
22
12e
25c
25e
25g
25i
25k

FIG.3

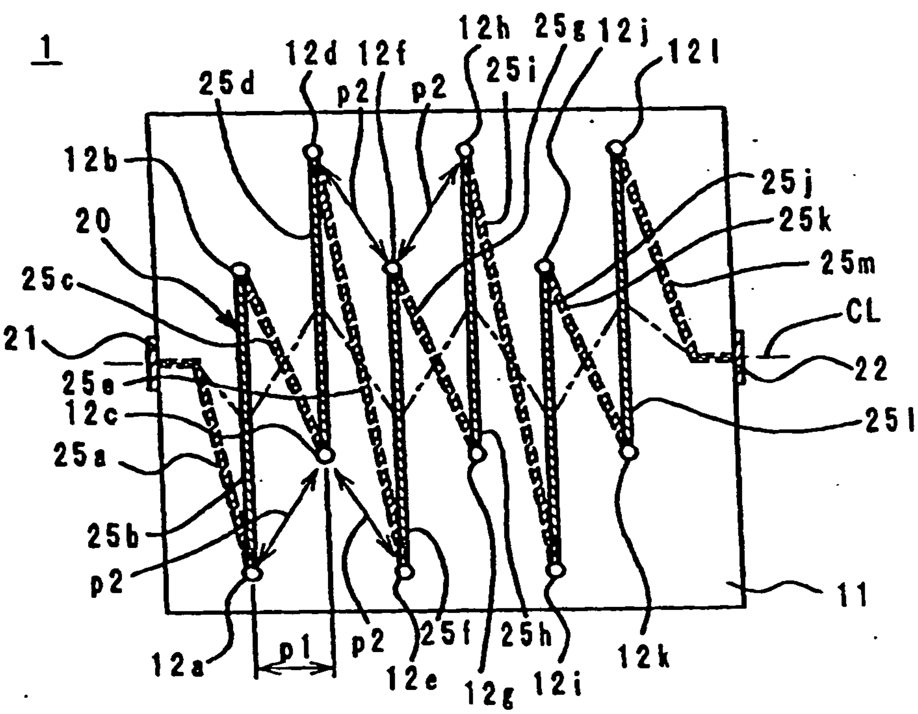

1
12d
12f
12h
25g
12j
12l
25d
p2
p2
25i
12b
25j
25k
20
25m
25c
CL
21
22
25e
12c
25l
25a
25b
p2
11
12a
p1
p2
25f
25h
12e
12g
12i
12k

FIG.4

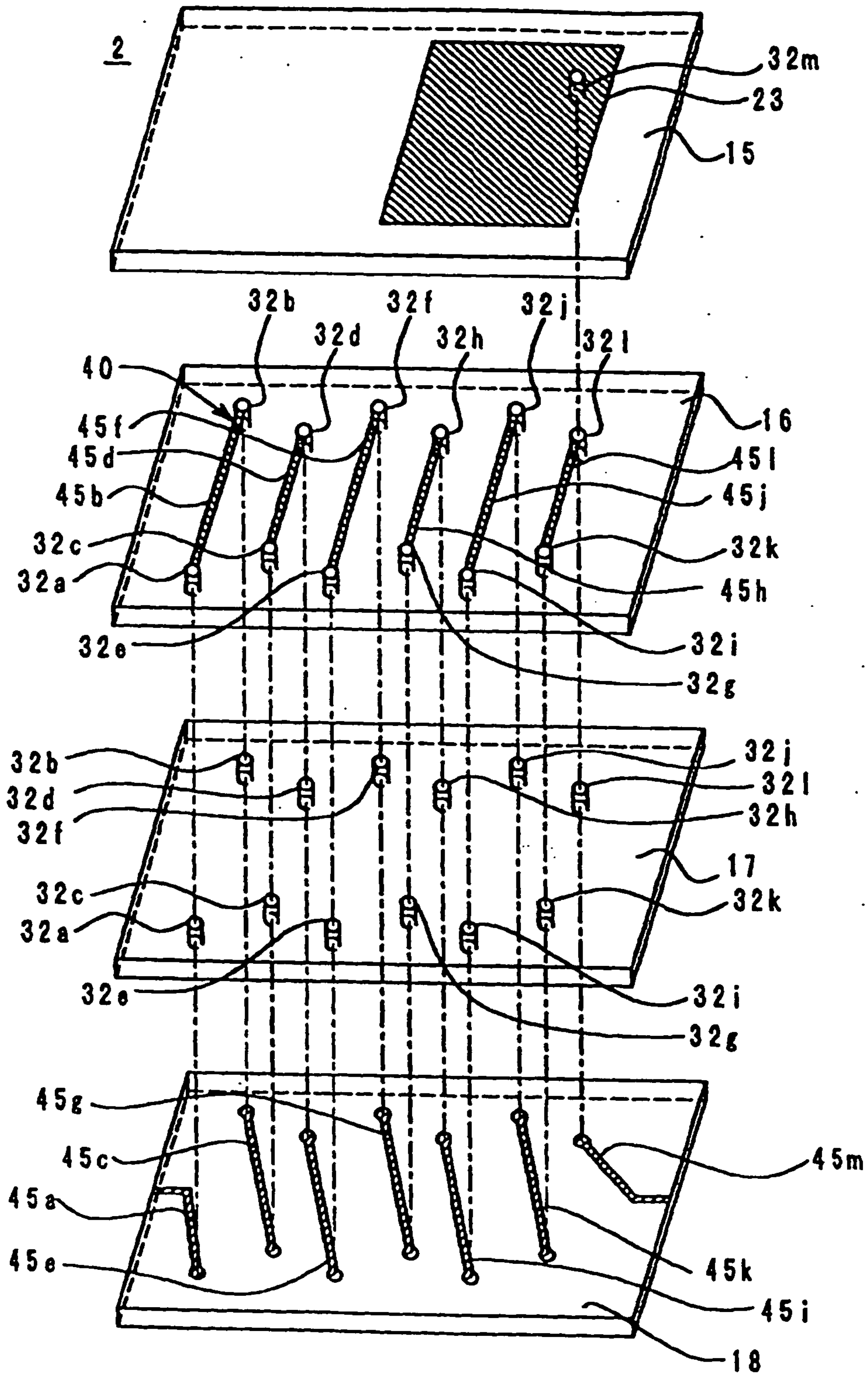

2
32m
23
15
32b
32f
32j
32d
32h
32l
40
16
45f
45d
45l
45b
45j
32c
32k
32a
45h
32e
32i
32g
32b
32j
32d
32l
32f
32h
17
32c
32k
32a
32e
32i
32g
45g
45c
45m
45a
45e
45k
45i
18

FIG.5

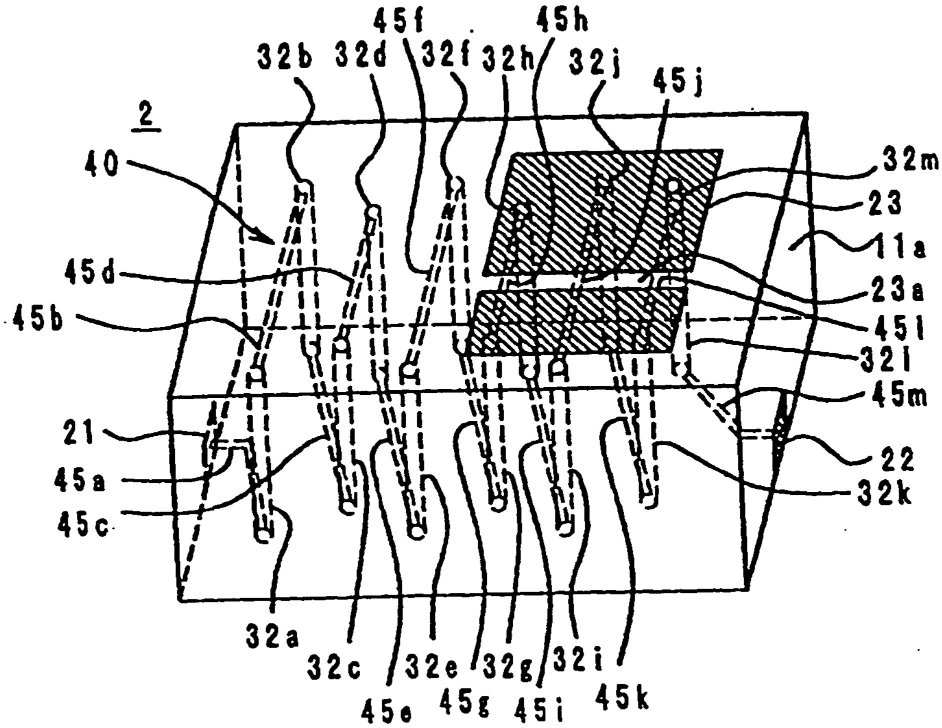
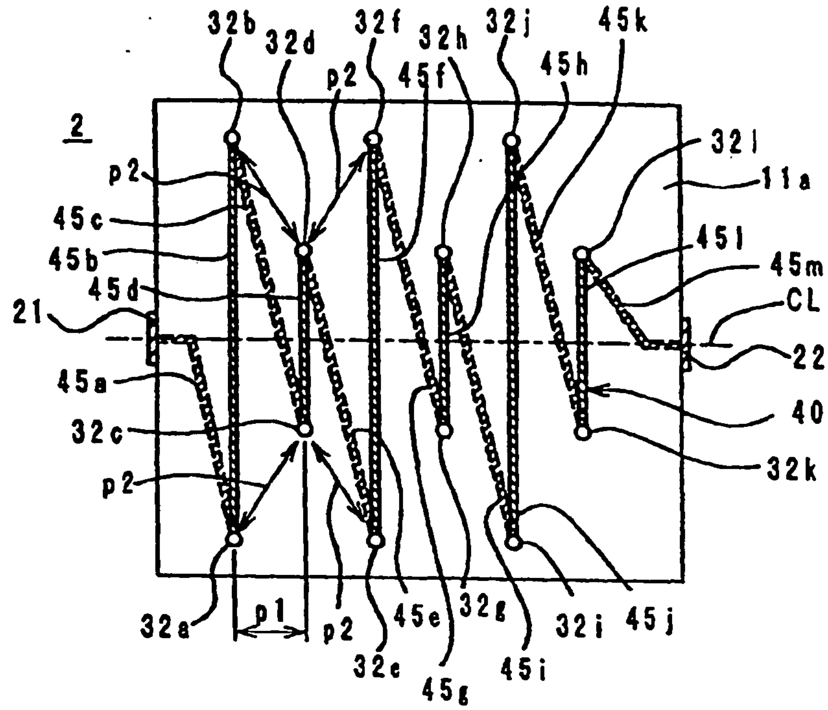
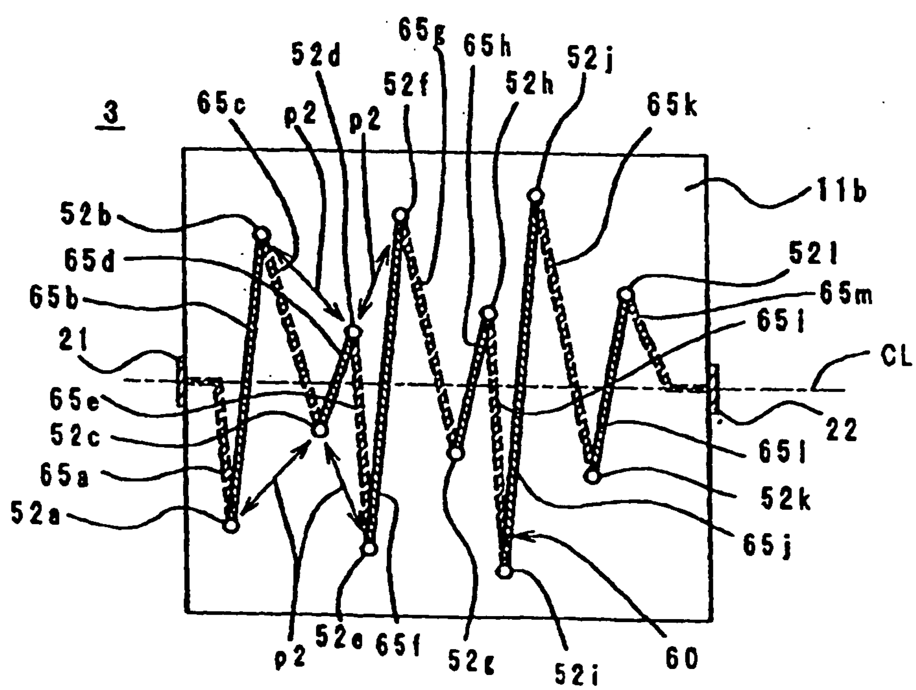

2
40
45b
45d
21
45a
45c
32b
32d
45f
32f
32h
45h
32j
45j
32m
23
11a
23a
45l
32l
45m
22
32k
32a
32c
32e
32g
32i
45e
45g
45i
45k

FIG.6



2
32b
32d
32f
32h
32j
45k
p2
45f
45h
32l
11a
p2
45c
45b
45d
45l
45m
CL
21
22
45a
40
32c
32k
p2
32a
p1
p2
45e
32g
32i
45j
32e
45g
45i

FIG.7



3
65g
65h
52d
52j
52f
52h
65c
p2
p2
65k
11b
52b
65d
52l
65b
65m
65i
21
CL
65e
22
52c
65l
65a
52k
52a
65j
p2
52e
65f
52g
52i
60

FIG.8

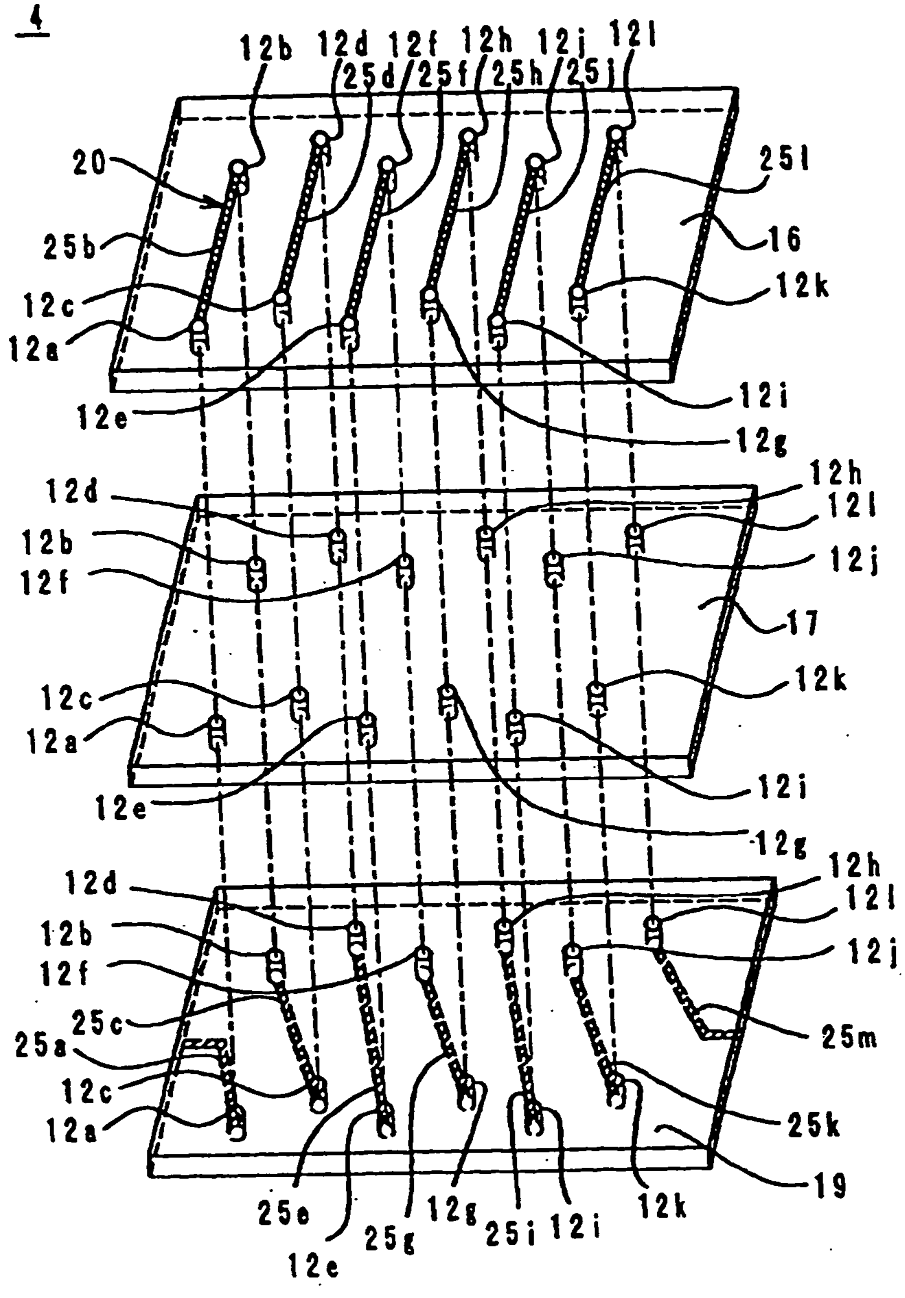

4
12b
12d
12f
12h
12j
12l
25d
25f
25h
25j
20
25l
25b
16
12c
12k
12a
12e
12i
12g
12d
12h
12l
12b
12j
12f
17
12c
12k
12a
12i
12e
12g
12d
12h
12l
12b
12j
12f
25c
25m
25a
12c
25k
12a
19
25e
12g
25i
12i
12k
25g
12e

FIG.9

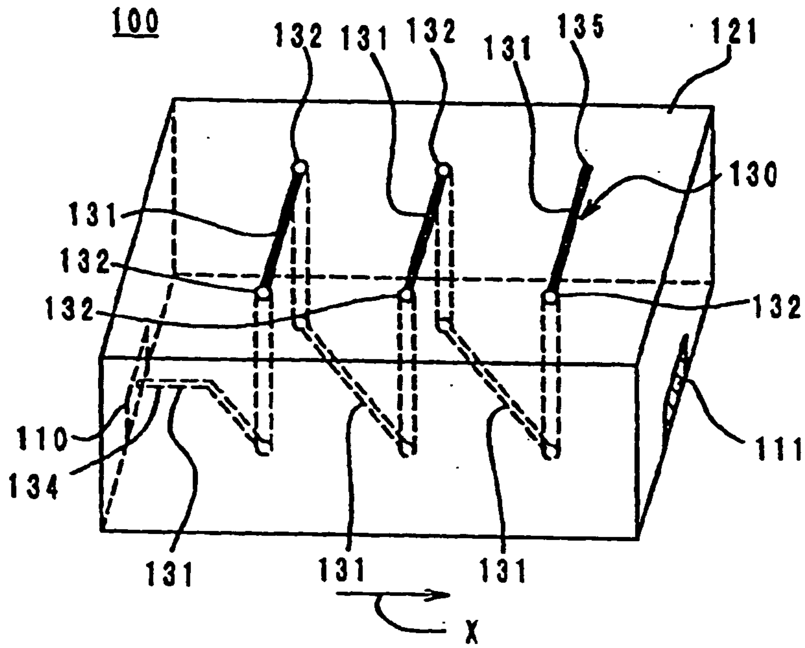
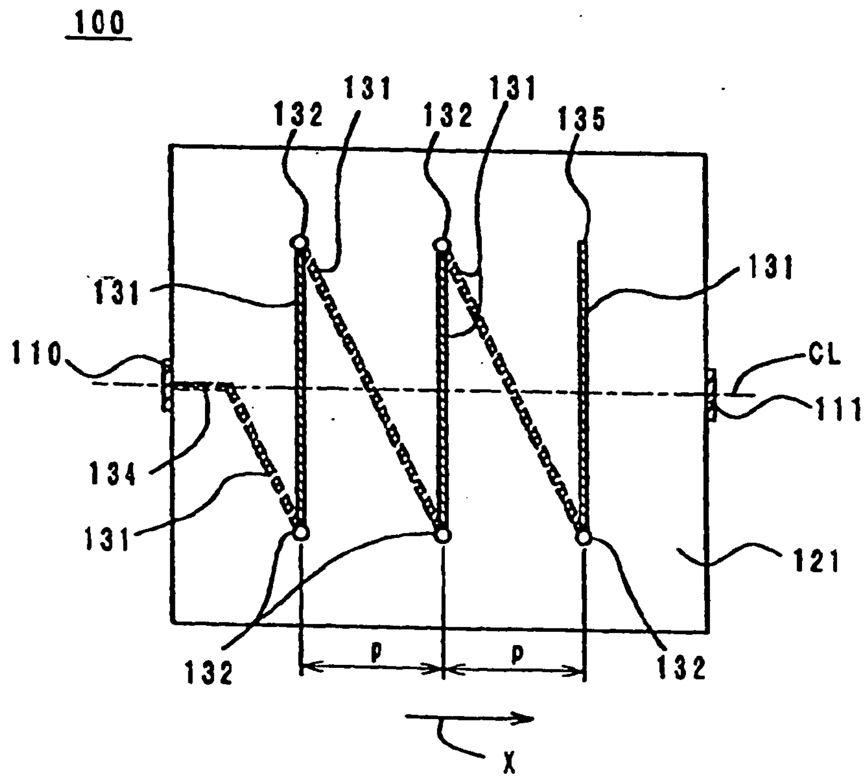

100
132
131
132
131
135
121
130
131
132
132
132
110
134
111
131
131
131
X

FIG.10


100
131
131
132
132
135
131
131
110
CL
111
134
131
121
132
P
P
132
X

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 01 11 6452

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X Y	PATENT ABSTRACTS OF JAPAN vol. 2000, no. 04, 31 August 2000 (2000-08-31) & JP 2000 013132 A (TDK CORP), 14 January 2000 (2000-01-14) * the whole document * ---	3-5,8, 10-13 6	H01Q11/08
Y	EP 0 863 570 A (MURATA MANUFACTURING CO) 9 September 1998 (1998-09-09) * page 3, line 30 - line 56 * * figures 1,2 * * abstract * ---	6	
X	PATENT ABSTRACTS OF JAPAN vol. 1998, no. 08, 30 June 1998 (1998-06-30) & JP 10 084216 A (SAITAMA NIPPON DENKI KK), 31 March 1998 (1998-03-31) * the whole document * ---	1,7	
X A	FR 2 702 091 A (ARNOULD APP ELECTR) 2 September 1994 (1994-09-02) * page 2, line 33 - page 6, line 30 * * figures 1-4 * ---	3,8 4,5, 10-13	TECHNICAL FIELDS SEARCHED (Int.Cl.7) H01Q
A	CARDOSO ET AL: "A spherical helical antenna" ANTENNAS AND PROPAGATION SOCIETY INTERNATIONAL SYMPOSIUM, 1993. AP-S. DIGEST ANN ARBOR, MI, USA 28 JUNE-2 JULY 1993, NEW YORK, NY, USA,IEEE, 28 June 1993 (1993-06-28), pages 1558-1561, XP010132848 ISBN: 0-7803-1246-5 * the whole document * -----	3	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
MUNICH	21 November 2001	von Walter, S-U

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO.

EP 01 11 6452

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

21-11-2001

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
JP 2000013132 A	14-01-2000	NONE	
EP 0863570 A	09-09-1998	JP 10247808 A EP 0863570 A2 EP 0863571 A2 US 6064351 A US 6028554 A	14-09-1998 09-09-1998 09-09-1998 16-05-2000 22-02-2000
JP 10084216 2 A		NONE	
FR 2702091 A	02-09-1994	FR 2702091 A1	02-09-1994

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

This Page Blank (uspto)